JP Laid-open No. 2001-285112 (complete translation)

[Claims]

[Claim 1]

A mobile object communication equipment characterized in that a radio part processing an analog signal comprises a multilayer substrate in which a plurality of dielectric layers formed of ceramics are laminated.

[Claim 2]

A mobile object communication equipment according to claim 1, characterized in that a passive part constituting the radio part is incorporated in the multilayer substrate, and an active part is mounted on the multilayer substrate.

[Claim 3]

A mobile object communication equipment according to claim 1 or 2, characterized in that the radio part comprises a GaAs switch switching transmission and reception, a high-frequency filter passing a reception signal, and an antenna switch part comprising a high-frequency filter or a directional coupler which passes a transmission signal.

[Claim 4]

A mobile object communication equipment according to claim 1 or 2, characterized in that the radio part is a transmission-side frequency conversion part comprising an orthogonal modular converting an oscillation signal from a fixed oscillator to an

intermediate-frequency signal for transmission, a buffer amplifier amplifying a local oscillation signal from a local oscillator, a mixer mixing the input intermediate-frequency signal for transmission and the local oscillation signal and outputting a transmission signal, and a high-frequency filer passing the transmission signal.

[Claim 5]

A mobile object communication equipment according to claim 1 or 2, characterized in that the radio part is a reception-side frequency conversion part comprising a low noise amplifier amplifying a reception signal, a high-frequency filter passing the reception signal, a buffer amplifier amplifying a local oscillation signal from a local oscillator and a mixer mixing the input reception signal and the local oscillation signal and outputting an intermediate-frequency signal for reception.

[Detailed Description of the Invention]

[0001]

[Technical Field to which the Invention Pertains]

The present invention relates to a mobile object communication equipment and more particularly, it relates to a mobile object communication equipment in which a radio part processing an analog signal comprises a multilayer substrate.

[0002]

[Prior Art]

Recently, a mobile phone operable in PDC (Personal Digital Cellular) system using 800 MHz band and 1.5 GHz band has been proposed as a mobile object communication equipment in Japan.

[0003]

Fig. 9 is a block diagram showing a radio part in a general PDC-system mobile phone. As disclosed in Japanese Unexamined Patent Publication No. 9-284168 or the like, the radio part in the PDC-system mobile phone comprises an antenna 1, an antenna switch part 2, a transmission-side amplification part 3, a transmission-side frequency conversion part 4, a first reception-side frequency conversion part 5, a second reception-side frequency conversion part 6, a PLL synthesizer part 7 and a base band part 8.

[0004]

The antenna switch part 2 comprises a GaAs switch SW switching a transmission part Tx and a reception part Rx, a directional coupler CPL outputting a part of a transmission signal to an automatic gain controller (not illustrated) and a band pass filter BPF1 passing a reception signal. The transmission-side amplification part 3 comprises a power amplifier PA amplifying the transmission signal and a band pass filter BPF2 passing the transmission signal. The transmission-side frequency conversion part 4 comprises an orthogonal modulator PSK generating an intermediate-frequency signal for transmission from an IQ signal from the base band

part 8 and an oscillation signal from a fixed oscillator LO1, a buffer amplifier BA1 amplifying a local oscillation signal from a local oscillator LO2, a mixer MIX1 mixing the input intermediate frequency signal for transmission and the local oscillation signal from the local oscillator LO2 and outputting the transmission signal, and a band pass filter BPF3 passing the transmission signal. The first reception-side frequency conversion part 5 comprises a low noise amplifier LNA1 amplifying the reception signal, a band pass filter BPF4 passing the reception signal, a buffer amplifier BA2 amplifying the local oscillation signal from the local oscillator LO2, and a mixer MIX2 mixing the input reception signal and the local oscillation signal from the local oscillator LO2 and outputting a first intermediate-frequency signal for reception. The second reception-side frequency conversion part 6 comprises an amplifier AMP1 amplifying the first intermediate-frequency signal for reception, a multiplier MU multiplying the oscillation signal from a crystal oscillator TCXO by N, a mixer MIX3 mixing the input first intermediate-frequency signal for reception and a signal from the multiplier MU and outputting a second intermediate-frequency signal for reception, and an amplifier AMP2 amplifying the second intermediate-frequency signal for reception. The PLL synthesizer part 7 comprises the local oscillator LO2 generating the local oscillation signal, a PLL circuit PLL controlling the local oscillator LO2, and the crystal

oscillator TCXO generating the oscillation signal. In addition, in the base band part 8, the transmission data such as voice is converted to the IQ signal or the second intermediate-frequency signal for reception is converted to voice data.

[0005]

[Problems that the Invention is to solve]

However, according to the mobile phone which is an example of the conventional mobile object communication equipment, since the antenna, the antenna switch part, the transmission-side amplification part, the transmission-side frequency conversion part, the reception-side frequency conversion part, the PLL synthesizer and the base band part which constitute the radio part are formed by mounting discrete components one by one on a circuit substrate, the number of parts is increased and accordingly a mounting area is increased, thereby enlarging the circuit substrate. As a result, the mobile phone (mobile object communication equipment) is enlarged.

[0006]

The present invention was made to solve the above problems and it is an object of the present invention to provide a mobile object communication equipment in which a radio part can be miniaturized.

[0007]

[Means of solving the Problems]

In order to solve the above problems, the mobile object communication equipment according to the present invention is characterized in that a radio part processing an analog signal comprises a multilayer substrate in which a plurality of dielectric layers formed of ceramics are laminated.

[0008]

In addition, according to a mobile object communication equipment of the present invention, it is characterized in that a passive part constituting the radio part is incorporated in the multilayer substrate, and an active part is mounted on the multilayer substrate.

[0009]

Still further, according to a mobile object communication equipment of the present invention, it is characterized in that the radio part comprises a GaAs switch switching transmission and reception, a high-frequency filter passing a reception signal, and an antenna switch part comprising a high-frequency filter or a directional coupler which passes a transmission signal.

[0010]

Still further, according to a mobile object communication equipment of the present invention, it is characterized in that the radio part is a transmission-side frequency conversion part comprising an orthogonal modular converting an oscillation signal from a fixed oscillator to an intermediate-frequency signal for transmission, a buffer amplifier amplifying a local

oscillation signal from a local oscillator, a mixer mixing the input intermediate-frequency signal for transmission and the local oscillation signal and outputting a transmission signal, and a high-frequency filer passing the transmission signal.

[0011]

Still further, according to a mobile object communication equipment of the present invention, it is characterized in that the radio part is a reception-side frequency conversion part comprising a low noise amplifier amplifying a reception signal, a high-frequency filter passing the reception signal, a buffer amplifier amplifying a local oscillation signal from a local oscillator and a mixer mixing the input reception signal and the local oscillation signal and outputting an intermediate-frequency signal for reception.

[0012]

According to the mobile object communication equipment of the present invention, since the radio part is provided with the multilayer substrate in which the plural dielectric layers are laminated, the antenna, the antenna switch part, the transmission-side amplification part, the transmission-side frequency conversion part, the reception-side frequency conversion part, a PLL synthesizer, and a base band part, which constitute the radio part, can be each connected in the multilayer substrate.

[0013]

[Embodiment of the Invention]

Hereinafter, an embodiment of the present invention is described with reference to the drawings. Fig. 1 is a partially broken perspective view showing an outer appearance of an antenna switch part constituting a radio part of a mobile object communication equipment of the present invention. The antenna switch part 10 corresponding to an antenna switch part 2 in a circuit constitution shown in Fig. 9 comprises a multilayer substrate 11 incorporating a directional coupler CPL (not illustrated) and a band pass filter BPF1 (not illustrated) comprising an LC filter which is a high-frequency filter.

[0014]

A bear chip-like GaAs switch SW is mounted on the multilayer substrate 11, and a resin 12 is applied on the upper face of the multilayer substrate 11 so that it covers the GaAs switch SW. In addition, five each of outer terminals T, twenty terminals in total, are formed on each side, from the side of the multilayer substrate 11 to the lower face. Ground terminals (not illustrated) are formed on the lower face of the multilayer substrate 11.

[0015]

Namely, according to the antenna switch part 10, the directional coupler CPL and the band pass filter BPF1, which are constituted of passive parts, are incorporated in the multilayer substrate 11, and the GaAs switch SW constituted of

active parts is loaded on the multilayer substrate 11.

[0016]

Fig. 2(a) and 2(b) are circuit diagrams of a directional coupler and a band pass filter which are incorporated in the multilayer substrate, respectively. The directional coupler CPL comprises a main line SL1 and a sub line SL2.

[0017]

The band pass filter BPF1 comprises inductors L1 and L2, and capacitors C1 to C5. The capacitor C1 and a parallel resonance circuit comprising the inductor L1 and the capacitor C2 are connected in series between one terminal and the ground, and the capacitor C3 and a parallel resonance circuit comprising the inductor L2 and the capacitor C4 are connected in series between the other terminal and the ground. In addition, the capacitor C5 is connected between one terminal and the other terminal. In this case, the inductors L1 and L2 are m-connected.

[0018]

Fig. 3(a) to 3(h) and Fig. 4(a) to 4(f) are views showing upper faces and lower faces of each dielectric layer constituting the multilayer substrate of the antenna switch part shown in Fig. 1. The multilayer substrate 11 is formed in such a manner that first to thirteenth dielectric layers 11a to 11m comprising ceramics having a dielectric constant of about 6, which are mainly composed of barium oxide, aluminum oxide and silica, are sequentially laminated from above and fired at a firing

temperature of 1000°C or less.

[0019]

A land La1 on which the GaAs switch SW is mounted is formed on the upper face of the first dielectric layer 11a. Furthermore, ground electrodes Gp11 to Gp14 are formed on the upper faces of the second, the fourth, the tenth and the thirteenth dielectric layers 11b, 11d, 11j and 11m, respectively.

[0020]

Still further, strip line electrodes Sp11 to Sp14 are formed on the upper faces of the third, the eleventh and the twelfth dielectric layers 11c, 11k and 11l, respectively. In addition, capacitor electrodes Cp11 to Cp19 are formed on the upper faces of the fifth to ninth dielectric layers 11e to 11i, respectively. Still further, an external terminal T and a ground terminal TG are formed on the lower face (to which reference sign of 11mu is allotted in Fig. 4(f)) of the thirteenth dielectric layer 11m.

[0021]

The strip line electrodes Sp11 to Sp14, the capacitor electrodes Cp11 to Cp19, the ground electrodes Gp11 to Gp14, the land La1, the external terminal T and the ground terminal TG are appropriately connected by a via hole electrode Vh1 formed in each dielectric layer.

[0022]

Then, the main line SL1 of the directional coupler CPL

is constituted of the strip line electrode Sp14 and the sub line SL2 thereof is constituted of the strip line electrode Sp13. Furthermore, the inductors L1 and L2 of the band pass filter BPF1 are constituted of the strip line electrodes Sp11 and Sp12, the capacitor C1 is constituted of the capacitor electrodes Cp11, Cp13, Cp16 and Cp18, the capacitor C2 is constituted of the capacitor electrodes Cp11, Cp18 and the ground electrodes Gp12 and Gp13, the capacitor C3 is constituted of the capacitor electrodes Cp12, Cp14, Cp17 and Cp19, the capacitor C4 is constituted of the capacitor electrodes Cp12 and Cp19 and the ground electrodes Gp12 and Gp13, and capacitor C5 is constituted of the capacitor electrodes Cp13, Cp15 and Cp17.

[0023]

In such constitution, there is formed the multilayer substrate 11 incorporating the directional coupler CPL and the band pass filter BPF1, which constitutes the antenna switch part 10 shown in Fig. 1. Then, The GaAs switch SW is mounted on the multilayer substrate 11 and the resin 12 is applied thereon, whereby the antenna switch part 10 shown in Fig. 1 is completed.

[0024]

Fig. 5 is a partially broken perspective view showing an outer appearance of a transmission-side frequency conversion part constituting the radio part of the mobile object communication equipment of the present invention. The transmission-side frequency conversion part 20 corresponding

to a transmission-side frequency conversion part 4 in the circuit constitution shown in Fig. 9 comprises a multilayer substrate 21 incorporating a band pass filter BPF3 (not illustrated) comprising an LC filter which is a high-frequency filter.

[0025]

A bear chip-like SI-IC 22 integrating an orthogonal modulator PSK, a buffer amplifier BA1 and a mixer MIX1 is mounted on the multilayer substrate 21, and a resin 23 is applied on the upper face of the multilayer substrate 21 so that it covers the SI-IC 22. In addition, five each of outer terminals T, twenty terminals in total, are formed on each side, from the side of the multilayer substrate 21 to the lower face. Ground terminals (not illustrated) are formed on the lower face of the multilayer substrate 21.

[0026]

In addition, a circuit of the band pass filter BPF3 incorporated in the multilayer substrate 21 is the same as the circuit of the band pass filter BPF1 shown in Fig. 2(b).

[0027]

Fig. 6(a) to 6(h) and Fig. 7(a) to 7(c) are views showing upper faces and lower faces of dielectric layers constituting the multilayer substrate of the transmission-side frequency conversion part shown in Fig. 5. The multilayer substrate 21 is formed in such a manner that first to tenth dielectric layers

21a to 21j comprising ceramics having a dielectric constant of about 6, which are mainly composed of barium oxide, aluminum oxide and silica, are sequentially laminated from above and fired at a firing temperature of 1000°C or less.

[0028]

A land La2 on which the SI-IC 22 is mounted is formed on the upper face of the first dielectric layer 21a. Furthermore, the ground electrodes Gp21 to Gp23 are formed on the upper faces of the second, the fourth, and the tenth dielectric layers 21b, 21d, and 21j, respectively.

[0029]

Still further, strip line electrodes Sp21 and Sp22 are formed on the upper face of the third dielectric layers 21c. In addition, capacitor electrodes Cp21 to Cp29 are formed on the upper faces of the fifth to ninth dielectric layers 21e to 21i, respectively. Still further, an external terminal T and a ground terminal TG are formed on the lower face (to which reference sign of 21ju is allotted in Fig. 7(c)) of the tenth dielectric layer 21j.

[0030]

The strip line electrodes Sp21 and Sp22, the capacitor electrodes Cp21 to Cp29, the ground electrodes Gp21 to Gp23, the land La2, the external terminal T and the ground terminal TG are appropriately connected by a via hole electrode Vh2 formed in each dielectric layer.

[0031]

Then, the inductors L1 and L2 of the band pass filter BPF3 are constituted of the strip line electrodes Sp21 and Sp22 and the ground electrodes Gp21 and Gp22, the capacitor C1 is constituted of the capacitor electrodes Cp21, Cp23, Cp26 and Cp28, the capacitor C2 is constituted of the capacitor electrodes Cp21 and Cp28 and the ground electrodes Gp22 and Gp23, the capacitor C3 is constituted of the capacitor electrodes Cp22, Cp24, Cp27 and Cp29, the capacitor C4 is constituted of the capacitor electrodes Cp22 and Cp29 and the ground electrodes Gp22 and Gp23, and capacitor C5 is constituted of the capacitor electrodes Cp23, Cp25 and Cp27.

[0032]

In such constitution, there is formed the multilayer substrate 21 incorporating the band pass filter BPF3, which constitutes the transmission-side frequency conversion part 20 shown in Fig. 5. Then, the SI-IC 22 is mounted on the multilayer substrate 21 and the resin 23 is applied thereon, whereby the transmission-side frequency conversion part 20 shown in Fig. 5 is completed.

[0033]

Fig. 8 is a partially broken perspective view showing an outer appearance of a reception-side frequency conversion part constituting the radio part of the mobile object communication equipment of the present invention. The reception-side

frequency conversion part 30 corresponding to a first reception-side frequency conversion part 5 in a circuit constitution shown in Fig. 9 comprises a multilayer substrate 31 incorporating a band pass filter BPF4 (not illustrated) comprising an LC filter which is a high-frequency filter.

[0034]

A bear chip-like GaAsMMIC 32 integrating a low noise amplifier LNA, a buffer amplifier BA2 and a mixer MIX2 is mounted on the multilayer substrate 31, and a resin 33 is applied on the upper face of the multilayer substrate 31 so that it covers the GaAsMMIC 32. In addition, five each of outer terminals T, twenty terminals in total, are formed on each side, from the side of the multilayer substrate 31 to the lower face. Ground terminals (not illustrated) are formed on the lower face of the multilayer substrate 31.

[0035]

In addition, similar to the above-described band pass filter BPF3, a circuit of the band pass filter BPF4 incorporated in the multilayer substrate 31 is the same as the circuit of the band pass filter BPF1 shown in Fig. 2(b).

[0036]

Therefore, the internal constitution of the multilayer substrate 31 is the same as that of the multilayer substrate 21 of the reception-side frequency conversion part (Fig. 5) shown in Figs. 6 and 7, and the GaAsMMIC 32 is mounted on the multilayer

substrate 31 and the resin 33 is applied thereto, whereby the reception-side frequency conversion part 30 shown in Fig. 8 is completed.

[0037]

According to the mobile objection communication equipment as described above, since the antenna switch part, the transmission-side frequency conversion part or the reception-side frequency conversion part, which constitutes the radio part is provided with the multilayer substrate formed of the plural laminated dielectric layers, an antenna, the antenna switch part, a transmission-side amplification part, the transmission-side frequency conversion part, the reception-side frequency conversion part, a PLL synthesizer, and a base band part, which constitute the radio part can be each connected in the multilayer substrate. Therefore, the radio part of the mobile object communication equipment can be miniaturized and the mobile object communication equipment comprising the radio part can be miniaturized.

[0038]

In addition, since the antenna switch part, the transmission-side frequency conversion part or the reception-side frequency conversion part, which constitutes the radio part is provided with the multilayer substrate formed of the plural laminated dielectric layers, matching between the active part and the passive part constituting each part can be

easily adjusted, and it is not necessary to provide a matching circuit for matching adjustment between them. Therefore, each part constituting the radio part can be miniaturized.

[0039]

Furthermore, since the antenna switch part, the transmission-side frequency conversion part or the reception-side frequency conversion part, which constitutes the radio part is provided with the multilayer substrate in which the plural dielectric layers are laminated, a loss because of a wiring between the active part and the passive part which constitute each part can be improved. Therefore, as a loss of a whole of each part constituting the radio part can be improved, high performance of the mobile object communication equipment comprising the radio part can be implemented at the same time.

[0040]

In addition, although the description was made of the case where the antenna switch part, the transmission-side frequency conversion part and the reception-side frequency conversion part, which constitutes the radio part of the mobile object communication equipment are formed on the different multilayer substrates in the above embodiment, it is all right as long as at least one of the antenna, the antenna switch part, the transmission-side amplification part, the transmission-side frequency conversion part, the reception-side frequency conversion part, the PLL synthesizer, and the base band part,

which constitute the radio part of the mobile object communication equipment is formed on the multilayer substrate, or the plural parts may be formed on one multilayer substrate all together. The same effect can be provided even when plural parts are formed on one multilayer substrate all together, that is, all of the antenna, the antenna switch part, the transmission-side amplification part, the transmission-side frequency conversion part, the reception-side frequency conversion part, the PLL synthesizer, and the base band part are formed on one multilayer substrate, for example.

[0041]

[Effect of the Invention]

According to the mobile object communication equipment of the present invention, since the radio part processing an analog signal comprises the multilayer substrate in which the plural dielectric layers formed of ceramics are laminated, each part constituting the radio part can be connected to each other in the multilayer substrate. Therefore, the radio part of the mobile object communication equipment can be miniaturized and the mobile object communication equipment comprising the radio part can be miniaturized.

[0042]

In addition, since the radio part processing the analog signal comprises the multilayer substrate in which the plural dielectric layers are laminated, matching between the active

part and the passive part which constitute the radio part can be easily adjusted, and it is not necessary to provide a matching circuit for matching adjustment between them. Therefore, each part constituting the radio part can be miniaturized.

[0043]

Still further, since the radio part processing the analog signal comprises the multilayer substrate in which the plural dielectric layers are laminated, a loss caused by a wiring between the active part and the passive part constituting the radio part can be improved. Therefore, as the loss of a whole of the radio part can be improved, high performance of the mobile object communication equipment comprising the radio part can be implemented at the same time.

[Brief Description of the Drawings]

[Fig. 1]

It is a partially broken perspective view showing an outer appearance of an antenna switch part constituting a radio part of a mobile object communication equipment according to the present invention.

[Fig. 2]

It shows circuit diagrams of a directional coupler (a) and a band pass filter (b) incorporated in a multilayer substrate comprising the antenna switch part shown in Fig. 1.

[Fig. 3]

It shows views of upper faces of the first dielectric layer (a) to the eighth dielectric layer (h) constituting the multilayer substrate comprising the antenna switch part shown in Fig. 1.

[Fig. 4]

It shows views of upper faces of the ninth dielectric layer (a) to the thirteenth dielectric layer (e) and a lower face of the thirteenth dielectric layer (f) constituting the multilayer substrate comprising the antenna switch part shown in Fig. 1.

[Fig, 5]

It is a partially broken perspective view showing an outer appearance of a transmission-side frequency conversion part constituting a radio part of the mobile object communication equipment of the present invention.

[Fig. 6]

It shows views of upper faces of the first dielectric layer (a) to the eighth dielectric layer (h) constituting the multilayer substrate comprising the transmission-side frequency conversion part shown in Fig. 5.

[Fig. 7]

It shows views of upper faces of the ninth dielectric layer (a) and the tenth dielectric layer (b) and a lower face of the tenth dielectric layer (c) constituting the multilayer substrate comprising the transmission-side frequency conversion part shown in Fig. 5.

[Fig. 8]

It is a partially broken perspective view showing an outer appearance of a reception-side frequency conversion part constituting the radio part of the mobile object communication equipment of the present invention.

[Fig. 9]

It is a block diagram showing a radio part in a general PDC-system mobile phone.

[Explanation of Reference Numerals and Signs in the Drawings]

10 Antenna switch part

20 Transmission-side frequency conversion part

30 Reception-side frequency conversion part

11, 21, 31 Multilayer substrate

22 Si-IC (Active part)

32 GaAsMMIC (Active part)

BA1, BA2 Buffer amplifier

BPF1 to BPF4 High-frequency filter

C1 to C5 Capacitor (Passive part)

CPL Directional coupler

L1, L2 Inductor (Passive part)

LNA Low noise amplifier

MIX1, MIX2 Mixer

PA Power amplifier

PSK Orthogonal modulator

SL1, SL2 Main line, Sub line (Passive part)

SW GaAs switch (Active part)